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DEPTHOMETER

BACKGROUND OF THE INVENTION

Field of the Invention (Technical Field):

The present invention relates generally to the field of instruments used for measuring distances. In particular, the present invention relates to instruments for measuring a length of an elongate line.

Background Art:

In the well drilling industry cables or wires are lowered into the well for determining well depths. The lack of identifying features on a cable render measurement of the length of cable lowered into the well difficult to determine from the position of the wellhead, or well opening. An early method of measurement commonly referred to as "stringing in" utilized a predefined length of cord to measure the length of cable entering a well, one predefined length at a time, until the desired maximum depth was reached.

Since that time wheeled measuring tools and others, commonly referred to as "depthometers", have replaced the stringing in method as a more efficient means for measuring line length. As used herein, the term "depthometer" refers to a measuring device used to measure the length of an elongate cable, wire, line or other elongate object (hereafter collectively referred to as a "line"). Conventional depthometers engage the line in some fashion such that the line passes through or alongside the instrument. As the line progresses through the instrument, the line rotates a wheel which in turn increments a registering mechanism that is calibrated to measure the length of the line in close approximation to the actual length passing through the instrument.

One such wheeled depthometer, manufactured by Cavins Company, was designed to replace the stringing in method and has seen widespread use in the oil and gas industry for decades. This depthometer engages the line at the wellhead, then is suspended in position by a tether or held in position with a stand mechanism. In this configuration the line is not translated beyond the relatively small area of the wellhead opening and the depthometer remains relatively fixed in position. The line

passes over a wheel of the Cavins depthometer as it is lowered into the well causing the wheel to rotate, which in turn increments a counter that presents a length measurement output to the user.

Over the past few decades there have been significant changes to operating procedures, methods, and standards used by the well industry, in particular the oil and gas industry. To accommodate newer procedures, the line must often be passed through additional mechanisms at the wellhead before being lowered into the well. Also, safety regulations limit physical contact between users and lines lowered into a well, as well as with instruments or mechanisms attached to, or engaged with lines. There has not, however, been a concurrent alteration to the design of depthometers to comply with revised operating and safety procedures.

One difficulty that arises when using depthometers is the obstruction caused by the wellhead lubricator. A lubricator is a section of pipe large enough to contain the tools necessary to perform certain tasks inside of a well bore. Completed wells employ lubricators to contain gas pressure or fluids for safety purposes. Attached to the top of the lubricator is a mechanism commonly referred to as an "oil saver", "pack off", or "blow out preventer," which contains a rubberized seal and can be compressed around the line into the well to contain gases and fluids. While depthometers are used on incomplete wells where gas and fluid containment may not be required, depthometers are most often used on completed wells in conjunction with a lubricator. The lubricator is generally at least twenty feet in height and is placed atop a typical wellhead, which is approximately five feet in height. A depthometer cannot be placed within the lubricator, therefore it must be placed at a height on the line above the wellhead that is beyond the grasp and visibility of the user.

To avoid the obstruction caused by the lubricator, depthometers are sometimes positioned in proximity to the draw-works drum used to take up and release the line. While this position provides the user improved access to the depthometer, the depthometer measurement output is presented to the user upside-down or in another position obstructing the ability of the user to read the output. Further, the depthometer must often be held by hand when positioned at the draw-works drum to obtain a reliable measurement, in violation of safety precautions. Safety precautions dictate that depthometers not be

held by hand while in use to prevent the user from coming into contact with the line or other moving parts. Instead, a stand or tether and suspension eye is used to hold the depthometer in position.

To complicate this situation, most depthometers do not securely engage the main measurement wheel to the line. Consequently, movement of the line or a slight pull on the depthometer often disengages the wheel from the line resulting in unreliable measurements. When mounting a depthometer in proximity to the cable drum, placing the depthometer on a stand or securing it by tether is impractical. As the line is released from the drum, it travels left to right as well as transversely as the layers of wound line diminish. This causes the depthometer to constantly change position in relation to the movement of the line. When placed on a stand the depthometer continuously disengages from the cable due to the constant movement of the cable. Further, when the depthometer is tethered in proximity to the drum, the weight of the depthometer tends to pull the main wheel away from the line thereby disengaging the instrument from the line.

Other difficulties with conventional depthometers include open spokes on main measuring wheels which can injure fingers if placed too close in proximity; awkward installation procedures of the depthometer upon the line; damage to the counter due to accumulated debris in open gear components; and broken or damaged idler arms that hold idler wheels due to fatigue and misalignment.

What is needed is an improved depthometer that securely engages a line and provides accurate measurements, is easily and efficiently installed and uninstalled from the line, and accommodates improved safety measures.

SUMMARY OF THE INVENTION (DISCLOSURE OF THE INVENTION)

The depthometer measures a length of an elongate line. The depthometer includes a main body component and a lower body component. A main wheel is mounted upon the main body component and one or more line guides are mounted upon the lower body component. The main wheel is in communication with a registering mechanism for providing a measurement output reflecting a length of the line. Means are provided for automatically moving the main body component towards the lower body component to engage the line.

Objects, advantages and novel features, and further scope of applicability of the depthometer will be set forth in part in the detailed description to follow, taken in conjunction with the accompanying drawings, and in part will become apparent to those skilled in the art upon examination of the following, or may be learned by practice of the depthometer invention. The objects and advantages of the depthometer may be realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated into and form a part of the specification, illustrate a preferred embodiment of the depthometer and, together with the description, serve to explain the principles of the depthometer. The drawings are not to be construed as limiting the depthometer.

Fig. 1 is a perspective front view of the depthometer installed upon an elongate line for measuring a length of the line;

Fig. 2 is a perspective rear view of the depthometer installed upon a line;

Fig. 3a is a rear view of the depthometer showing a user grasping and squeezing the inner and outer handles together to open the depthometer;

Fig. 3b is a front view of the depthometer in the open position showing a user positioning a line into the depthometer;

Fig. 3c is a rear view of the depthometer showing a user releasing the inner handle from the outer handle to close the depthometer and engage a line;

Fig. 4 is a close up front view of the depthometer;

Fig. 5 is a close up rear view of the depthometer; and

Fig. 6 is an exploded perspective view of the depthometer; and

Fig. 7 is an exploded perspective view of a portion of the main and lower body components, and inner and outer handles of the depthometer.

DESCRIPTION OF THE PREFERRED EMBODIMENTS
(BEST MODES FOR CARRYING OUT THE INVENTION)

Figs. 1, 2 and 3 provide an overview of the operation of depthometer **10** used for measuring a length of an elongate line. Referring to Fig. 1, a perspective front view of depthometer **10** installed upon an elongate line **20** for measuring a length of line **20** is shown. Depthometer **10** engages line **20** in a secure manner when in the installed position.

First, or inner, handle **14** is used in conjunction with second, or outer, handle **16** to open and close two adjacent and opposing body components, **26** and **28**, of the body of depthometer **10** that serve as means for mounting line guides and a wheel. Inner handle **14** and outer handle **16** additionally provide a means for grasping the depthometer **10**. When a user grasps inner handle **14** and outer handle **16** and squeezes inner handle **14** towards outer handle **16**, first, or main, body component **28** of depthometer **10** is displaced from second, or lower, body component **26**. This displacement produces a gap between the body components, wherein a user positions a line **20** between a wheel and line guides of depthometer **10** that are mounted upon main and lower body components respectively. (See also Fig. 2.)

Releasing inner handle **14** allows a spring-like force to automatically move main body component **28** towards lower body component **26**, thereby reducing the gap between the components, and engaging line **20** between wheel and line guides of depthometer **10** in the installed position. As used herein the term "spring-like" force means a force created by a spring or by any other mechanism that automatically provides a force when released from being restrained in a position in opposition to an at-rest position. Although a spring is depicted in the figures, other mechanisms can be used in the alternative to create this force. Means for producing a spring-like force include but are not limited to springs, hydraulic devices, and air-driven devices. Therefore, means for automatically moving main body component **28** towards lower body component **26** include but are not limited to springs, hydraulic devices, and air-driven devices.

Once line **20** is installed in depthometer **10** and passes through depthometer **10**, registering mechanism **18** presents a length measurement visible to a user on display **40**. Tether **12** is optionally

connected to outer handle **16** and provides additional security to depthometer **10** when installed on line **20**.

Referring to Fig. 2, a perspective rear view of depthometer **10** installed upon an elongate line **20** for measuring a length of line **20** is shown. Main wheel **22** is rotatably connected to main body component **28** and is rotated by frictional contact with line **20** as line **20** passes through depthometer **10** when in the installed position and engaged by the depthometer. As line **20** passes through depthometer **10** it moves tangentially along main wheel **22**. Main wheel **22** in turn increments registering mechanism **18** (Fig. 1) to provide a measurement output. Line guides **24, 24'** connected to lower body component **26** guide line **20** through depthometer **10** and provide an opposing force to that of main wheel **22** against line **20** to stabilize the installed line **20** in a secure engaged position and to maintain frictional contact between line **20** and main wheel **22** when pressed towards main wheel **22** by a spring-like force.

Line guides **24, 24'** include various mechanisms for guiding a line including but not limited to idler wheels **24, 24'** rotatably connected to lower body component **26**. Alternatively, line guides **24, 24'** comprise non-rotating mechanisms connected to lower body component **26**, having grooves within which line **20** slides when passing through depthometer **10**. It will be understood that while two line guides are depicted in the figures, a single line guide could achieve the identical function, way and result.

Preferably, the outer circumferential ring of main wheel **22** upon which line **20** travels is a sufficiently durable material, such as, but not limited to steel. If the circumference of main wheel **22** is not a sufficiently durable material, the line tends to wear down the surface, resulting in a smaller effective diameter of main wheel **22** and inaccurate length measurement.

Examination of Figs. 1, 2 and 3 reveals the effective and simple manner of securely installing depthometer **10** upon a line, which eliminates the need for holding the depthometer by hand, by a stand, or by any other mechanism while taking a measurement. Figs. 3a, 3b and 3c show the methodology of installing depthometer **10** upon line **20**. Referring to Fig. 3a, a rear view of depthometer **10** is shown. A user grasps inner handle **14** and outer handle **16** and squeezes inner handle **14** towards outer handle **16** to open depthometer **10**. This squeezing action is in opposition to the force of spring **32** against main body component **28** caused by the tendency of the spring to return to its natural resting position. Inner

handle **14** is connected to main body component **28**. Outer handle **16** connects to and slidably engages main body component **28** and is connected to lower body component **26**. The action of squeezing inner handle **14** towards outer handle **16** pulls main body component **28** away from lower body component **26** leaving a gap **30** between component **26** and component **28** and separating main wheel **22** from opposing idler wheels **24, 24'**.

Turning to Fig. 3b, a front view of depthometer **10** is shown in the open position. While squeezing inner handle **14** towards outer handle **16** to maintain gap **30**, a user positions line **20** substantially parallel to gap **30** such that line **20** is placed adjacent main wheel **22**, between main wheel **22** and opposing idler wheels **24** and **24'**. As shown in Fig. 3c, a rear view, release of inner handle **14** allows the force of spring **32**, returning to a resting position, to automatically move main body component **28** towards lower body component **26**, reducing the width of gap **30** to an extent that engages line **20** in a substantially tangential manner between opposing main wheel **22** and idler wheels **24, 24'**.

Although spring **32** can comprise different materials, types, and sizes, spring **32** should provide enough force against main body component **28** to aid in securing line **20** between main wheel **22** and idler wheels **24, 24'**. A compression spring is desirable as it fatigues less readily than an expansion spring. While between approximately ten and fifteen pounds of force to squeeze inner handle **14** towards outer handle **16** is typically appropriate, the amount of spring force necessary to secure line **20** between the wheels is related to the diameter of the line.

Referring to Fig. 4, a front view of depthometer **10** is shown. Registering mechanism **18** has a rotary counter and is available and known in the art; therefore, the inner workings and configuration of registering mechanisms are not described here. One example of such a registering mechanism is manufactured by Redding, Inc.. Registering mechanism **18** is mounted upon bracket **34** that is mounted to main body component **28**. Bracket **34** is affixed to main body component **28** by connecting means **38** such as, but not limited to, bolts and nuts, welding, rivets, other connecting means, or combination thereof. Bracket **34** includes a planar portion that is adjacent and parallel to the plane defined by main body component **28** and a ledge portion **36** that extends orthogonally outward from the plane defined by main body component **28**.

Registering mechanism **18** is in communication with main wheel **22**, having a shaft passing through bracket **34** and main body component **28** as described with reference to Fig. 6. Rotation of main wheel **22** increments registering mechanism **18** which provides a measurement output visible to a user on display **40**. For example, a single revolution of main wheel **22** could increment registering mechanism **18** to indicate passage of a one-foot length of line through depthometer **10**. As is known, the radius of main wheel **22** and the internal configuration of registering mechanism **18** affect the measurement output of depthometer **10**. Thus the radius of main wheel **22** and the type of registering mechanism **18** must correspond to produce an accurate or nearly accurate measurement output as will be apparent to those of skill in the art. It will be apparent to those of skill in the art that registering mechanism **18** provides either a mechanical output, electrical output such as a digital output on a light emitting diode (LED) display or other display, or any combination thereof to indicate a measurement on display **40**. With continuing reference to Fig. 4, idler wheels **24, 24'** (Figs. 3a, 3b and 3c) are rotatably connected to lower body component **26** at points **42, 42'**.

Referring to Fig. 5, a rear view of depthometer **10** is shown. Idler wheels **24, 24'** are shown rotatably connected to lower body component **26** at points **42, 42'**. Idler wheels **24, 24'** are lubricated through lubrication mechanisms **46, 46'**, such as grease zerks. Main wheel **22** is rotatably connected to main body component **28** at **44**.

Inner handle **14** is connected to main body component **28** such that a user can grasp inner handle **14** and pull main body component **28** away from lower body component **26** and towards outer handle **16**. Outer handle **16** slidably engages main body component **28** and is connected to lower body component **26**. (See also Fig. 7.) Outer handle **16** consists of shafts **48, 48'** and a transverse portion **54** that is grasped by hand. Transverse portion **54** of handle **16** is connected at opposing ends to shafts **48, 48'** that extend perpendicularly from opposing ends of portion **54**. Transverse portion **54** is connected to shafts **48, 48'** by any appropriate means such as, but not limited to, threadedly inserting shaft **48** through a mating opening, or bore, defined in transverse portion **54** and further securing the two components together by appropriate connecting means such as but not limited to nuts secured on mating threads of shaft **48**. Alternatively, transverse portion **54** is welded to shaft **48** or connected by connecting means

such as rivets. It will be appreciated by those of skill in the art that handle **16** can of course be comprised of a single, integral U-shaped unit that provides both the transverse portion **54** and shafts **48**, **48'**.

Inner handle **14** is depicted in the figures as a U-shaped component. In an alternative embodiment, inner handle **14** comprises a T-shaped component consisting of a transverse bar connected to a single shaft portion that is connected to main body component **28**, instead of a transverse bar connected to two shaft portions connected to the main body component **28** as shown in the figures.

As shown in Fig. 5, stopping mechanisms **50**, **52** such as but not limited to nuts threaded onto shaft **48** via mating threads on shaft **48** on opposing sides of an end of transverse portion **54**, secure portion **54** of handle **16** in a stable position at a point along the length of shaft **48**. Stopping mechanism **52** additionally provides a stop to the far end of spring **32** inserted over shaft **48**. It will be apparent to those of skill in the art that stopping mechanisms **50**, **52** are optional particularly when transverse portion **54** of handle **16** is connected to shafts **48**, **48'** in permanent fashion, for example by welding portion **54** to shaft **48**. Spring **32** is compressible and expandable along shaft **48** between main body component **28** and transverse portion **54** of handle **16**. Stopping mechanism **50** is preferably fixed permanently to shaft **48**, such as by welding, so that rotation of mechanism **50** results in simultaneous rotation of shaft **48**. This is particularly useful for adjusting the tension of spring **32** should spring **32** become fatigued from wear.

Fig. 6 provides an exploded view of depthometer **10**. A groove **56** is defined around the circumference of each idler wheel **24** to provide a recessed area for a line to rest within and be held stable while passing through the depthometer. Each idler wheel **24** defines an opening **58** through which an axis for rotation of the wheel securely fits. Within opening **58** is a series of bearings **60**. Wheel axis **62** passes through sleeve **64** within opening **58**. Lubricant is provided to idler wheel **24** through lubrication mechanism **46**. Threaded end **66** of axis **62** is passed through mating opening, or bore, **42** of lower body component **26** with washer **68** against lower body component **26** to secure axis **62** in position on lower body component **26**. Preferably, threaded end **66** extends through opening **42** to an extent that

the bottom surface of threaded end **66** is flush with the plane of the lower body component **26** on the side opposite the side from the idler wheel **24**.

Means for registering a length of an elongate line are provided by registering mechanism **18**. Main wheel **22** is in communication with registering mechanism shaft **72**. Registering mechanism shaft **72** passes through mating openings, or bores, **44** defined in bracket **34** and main body component **28** respectively. A series of bearings **76** are provided within opening **44**. Registering mechanism shaft **72** passes through sleeve **78** that is inserted within opening **44**. Washer **80** is inserted over shaft **72** between main body component **28** and registering mechanism. Registering mechanism **72** defines a threaded opening longitudinally through its entire length, and lubrication mechanism, or grease zerk, **73** threaded into shaft **72** provides a means for lubricating bearings **76**.

Registering mechanism **18** is preferably removable from bracket **34** to permit installation of a replacement registering mechanism in the event that registering mechanism parts become worn. A first end of registering mechanism shaft **72** is in communication with registering mechanism **18** which contains display **40** (Fig. 1). Connection means, such as but not limited to, a set screw, inserted through the mating opening of registering mechanism **18** and into shaft **72**, attaches registering mechanism **18** to shaft **72**. The opposite end of shaft **72** and associated key stock **70**, which is passed through openings **44** defined in bracket **34** and main body component **28**, continues through opening **74** defined in main wheel **22** with washer **82** between main body component **28** and main wheel **22**. Nut **84** is secured on the end of shaft **72** on the side of main wheel **22** furthest from main body component **28**. Key stock **70** is fixed in mating slot **71** of opening **74** defined in main wheel **22**, thus rotation of main wheel **22** rotates registering mechanism shaft **72**, which in turn increments the measurement output upon display **40**. A plate **86** is connected between registering mechanism **18** and ledge portion **36** of bracket **34** with connecting means **88** such as but not limited to screws, rivets, or nuts and bolts to connect registering mechanism **18** to bracket **34**.

Referring to Fig. 7, an exploded view of a portion of the lower body component **26**, main body component **28**, inner handle **14**, and outer handle **16** is shown. Each shaft **48** of handle **16** is securely connected at opposing ends to lower body component **26** and transverse portion **54** of handle **16**,

respectively. One way to secure shaft **48** to lower body component **26** and transverse portion **54** is by providing threads upon shaft **48** at opposing ends and providing mating openings for receiving the threaded ends of shaft **48** within lower body component **26** and transverse portion **54** of handle **16**. It will of course be apparent to those of skill in the art that shaft **48** can be connected to lower body component **26** and to transverse portion **54** by other means, such as by welding.

However, as shown in Fig. 7, threaded end **90** of shaft **48** is threadedly inserted into mating opening **92** defined in lower body component **26** to a depth sufficient to securely fix shaft **48** to lower body component **26**. The central portion of shaft **48** extends through bore **98** defined in main body component **28**. Bore **98** is smooth and of slightly larger diameter than that of shaft **48** such that main body component **28** can slide along the length of shaft **48** without being obstructed by the threads upon shaft **48**. It will of course be apparent that shaft **48** need not be threaded on its entire length but instead be smooth for that length upon which main body component **28** slidably engages. In that instance, bore **98** need only be of a diameter sufficient to contain the diameter of shaft **48**.

Threaded end **94** is inserted through mating opening **96** defined in transverse portion **54** of handle **16**. Stopping mechanisms **50** and **52** secure shaft **48** and transverse portion **54** of handle **16** at the point where they join.

Inner handle **14** is securely connected to main body component **28**. Mating openings **100, 102,** defined in handle **14** and main body component **28** respectively, receive bolt **104** to join inner handle **14** and main body component **28** together in a permanent manner. Alternatively, as will be apparent, handle **14** and main body component **28** are joined by other connecting means such as but not limited to welding. Or, handle **14** and main body component **28** can together form a single integral unit, formed by a single mold.

Spring **32** is positioned longitudinally over shaft **48** between transverse portion **54** of handle **16** and the upper surface of main body component **28**. Main body component **28** is pressed towards lower body component **26** by the expansion force of spring **32**. Squeezing inner handle **14** toward outer handle **16** compresses spring **32**. The release of inner handle **14** allows the compressed spring **32** to

expand. The expansion force of spring **32** automatically presses main body component **28** towards lower body component **26**, thereby engaging the line.

It will be understood by those of skill in the art that the components of depthometer **10** can be of a variety of shapes, sizes, dimensions, and materials. The depthometer is not to be limited to the shapes, sizes, and dimensions depicted in the figures.

Although the depthometer has been described in detail with reference to these preferred embodiments, other embodiments can achieve the same results. Variations and modifications of the present depthometer will be obvious to those skilled in the art and it is intended to cover in the appended claims all such modifications and equivalents.